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Effects of Threat on Police Officers' Shooting Behavior: Anxiety, Action Specificity, and Affective Influences on Perception

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Summary: In the current study, we investigated the impact of threat and response mode on police officers' distance perception and shooting behavior in relation to a suspect that approached with a knife. To manipulate threat and increase anxiety, the suspect carried either a plastic knife (low threat) or an electrical knife (high threat). Regarding the manipulation of response mode, officers provided either an actual shooting response or indicated their shot verbally. In both cases, perceptual judgments of shooting distances were assessed through visual matching. Results show that high threat led to earlier shooting, but only for actual shooting responses. Although high threat generally induced more anxiety, perceptual judgments remained unaffected by threat and indicated systematic underestimations of the distance to the suspect. It is suggested that in the online control of action, increased anxiety does not affect distance perception but alters the functional relationship between distance and perceived threat, thereby causing officers to shoot the approaching suspect at an earlier stage. Copyright © 2012 John Wiley & Sons, Ltd.

Police officers are often confronted with aggressive behavior of civilians (e.g. Anderson, Litzenberger, & Plecas, 2002). In such situations, the distance between an officer and a suspect is important in deciding how to respond (e.g. verbally or physically and shoot or do not shoot). For instance, when a suspect that carries a knife approaches a police officer, the officer may—at a large distance —verbally order the suspect to drop the knife but decide to draw a handgun and shoot when the suspect gets dangerously close. By law, police officers have to select their responses on the basis of the level of threat that they encounter, which often varies depending on the distance to a suspect. However, in such threatening situations, distance judgments may not be as accurate as they are supposed to be.

Recent work by Proffitt (2006a, 2006b) suggests that distance perception is not solely based on objective information that is specified by the environment but also on physiological and psychological states (e.g. Proffitt, Stefanucci, Banton, & Epstein, 2003; Stefannuci & Proffitt, 2009; Stefanucci & Storbeck, 2009; Teachman, Stefanucci, Clerkin, Cody, & Proffitt, 2008; Witt & Proffitt, 2008). For instance, with respect to fear, Teachman et al. (2008) showed that people who are afraid of heights tend to perceive heights as being higher than people who are not afraid of heights (cf. Clerkin, Cody, Stefanucci, & Teachman, 2009; Stefanucci & Proffitt, 2009).

When people are afraid of something, this is related to their perception of the environment in terms of anticipated events (e.g. falling down from a high balcony). Correspondingly, Proffitt and colleagues (Proffitt, 2006b) have shown that psychological and physiological states primarily influence perception when observers consider their *possibilities* for action (see also Witt & Proffitt, 2008). For example, Witt, Proffitt, and Epstein (2005) showed that when people hold a tool and judge target-related distances, perceived distance decreases only when people intend to use the tool to actually reach to the targets (and not when they are holding the tool without intending to reach to the targets). Similarly, when standing on a high balcony, perceived height is increased when people are asked to specifically imagine themselves falling down (e.g. Clerkin et al., 2009).

An important implication of the work of Proffitt and colleagues is that changes in perception (e.g. perceiving targets to be closer than they are) may lead to accompanying changes in decision making and action (e.g. attempting to reach to targets that are actually too far away). However, whether psychological and physiological influences on perception indeed affect actual behavior has not been investigated yet. To this end, the current study aimed to examine affective influences on perception (e.g. Clerkin et al., 2009; Stefanucci & Proffitt, 2009; Teachman et al., 2008) and explored the extent to which these might differentially influence actually executed actions or verbal indications of action intention.

Specifically, our aim was to explore how threat influences police officers' shooting behavior in relation to a suspect that approaches with a knife. Because in this situation threat is related to distance and distance perception may be affected by threat (Clerkin et al., 2009; Stefanucci & Proffitt, 2009; Teachman et al., 2008), it is reasonable to assume that affective influences on perception may alter the distance at which police officers decide to shoot an approaching suspect. That is, because a suspect with a knife becomes increasingly dangerous as he or she continues to approach, increases in anxiety may lead officers to perceive the suspect as being closer and, hence, cause them to shoot earlier (i.e. at a greater distance).

Clearly, there is a difference between providing perceptual judgments *per se* and actually executing actions on the basis of visual information. In this respect, recent work on the processing of visual information suggests that perceptual accuracy is improved by the amount of action-specific movement that is allowed in responding to specific situations (e.g. Króliczak, Heard, Goodale, & Gregory, 2006; Króliczak, Cavina-Pratesi, Goodman, & Culham, 2007; Mann, Abernethy, & Farrow, 2010). For example, using a visual-occlusion paradigm, Mann et al. (2010) asked expert cricketers to judge the direction of

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balls that were bowled at them by means of four different responses, including 'verbal indication', 'initial foot displacement', 'shadow batting', and 'actual hitting attempts'. Generally, it was shown that with more action-specific responses, accuracy of perceptual judgments increased. The explanation for this finding is that visual information may be processed along different neural pathways depending on whether people are engaged in action or not, and that these pathways—dorsal and ventral—have clearly distinguishable characteristics (Milner & Goodale, 1995; see also Van der Kamp, Rivas, Van Doorn, & Savelsbergh, 2008). That is, the *dorsal pathway* is sensitive to movement and information that specifies environmental layout and is primarily involved in the online control of action, whereas the *ventral pathway* is less sensitive to this kind of information and is primarily used to provide contextual (meaningful) interpretations of our surroundings. With these characteristics, one might argue that when participants are allowed to *actually* shoot at a suspect, this leads to faster processing of visual information (e.g. Eimer & Schlaghecken, 2001) and a more accurate perception of distance than when they provide a *verbal* indication of their shooting response (see Bhalla & Proffitt, 1999, for a similar argument regarding slant perception). Furthermore, because in this context threat increases with decreases in distance (i.e. distance and threat are tightly coupled), a more accurate perception of distance might also mean that people are more sensitive to threat.

Although previous work has shown that threat-induced increases in anxiety may lead to an altered perception of distance (e.g. Stefanucci & Proffitt, 2009; Teachman et al., 2008), it is also known that anxiety can influence how situations are interpreted (e.g. Calvo & Costillo, 2001; Nieuwenhuys, Savelsbergh, & Oudejans, in press; see also Bishop, 2007; Blanchette & Richards, 2010; Nieuwenhuys & Oudejans, in press). In this case, distance perception may remain unaltered while what is perceived is interpreted differently on the basis of one's current feeling or state. For example, Nieuwenhuys et al. (in press) asked police officers to shoot or not to shoot at rapidly appearing suspects that either had a gun and 'shot' or had no gun and 'surrendered'. When the officers were more anxious (as they could actually get hurt by the suspects' shots), they showed a response bias towards shooting, meaning that they accidentally shot more often at suspects that surrendered. Underlying this effect, an analysis of gaze behavior indicated that the officers showed similar scan paths and fixated the suspect equally fast, regardless of their anxiety. However, when the officers shot at surrendering suspects, this was characterized by response times that were approximately 100 ms (20%) faster than normal shooting responses. With these results, Nieuwenhuys et al. concluded that under high anxiety, officers did not wait for visual information that showed whether suspects actually had a gun or not, but instead more often responded on the basis of threat-related interpretations that were triggered merely by the suspects' appearance (cf. Correll, Park, Judd, & Wittenbrink, 2002; Payne, 2001).

Following this line of reasoning, if police officers are more anxious and this causes them to be quicker in shooting at an approaching suspect, one possibility is that this occurs through affective influences on perception, which would cause officers to perceive the suspect as being closer (e.g. Stefanucci & Proffitt, 2009; Teachman et al., 2008). However, another possibility is that distance perception remains the same while the relation between distance and perceived threat is changed, thereby causing officers to be quicker in interpreting the situation as 'worthy of shooting' (e.g. Nieuwenhuys et al., in press).

In the current study, we examined these alternative explanations by asking police officers to respond to a suspect that approached with a knife and to actually 'shoot' the suspect if he came too close. To experimentally manipulate threat, the suspect approached participants with either a plastic knife (low threat) or an electrical knife (high threat). Furthermore, to manipulate response mode, we divided participants into two groups: one group that actually shot the suspect (by means of colored-soap cartridges; e.g. Nieuwenhuys & Oudejans, 2010, 2011) and one group that provided a verbal indication of their shot. Directly after shooting, perceived shooting distance was assessed through visual matching (e.g. Proffitt et al., 2003; Witt, Stefanucci, Riener, & Proffitt, 2007).[1]

In general, we anticipated that when the suspect approached with an electrical knife (high threat), participants would experience more anxiety. If high threat would indeed lead to more anxiety, based on previous work, we predicted that this would result in earlier shooting (e.g. Corell et al., 2002; Nieuwenhuys & Oudejans, 2010, 2011; Nieuwenhuys et al., in press; Payne, 2001). We reasoned that if this effect would be due to affective influences on perception (Clerkin et al., 2009; Stefanucci & Proffitt, 2009; Teachman et al., 2008; see also Proffitt, 2006a, 2006b), then this should be reflected by increased underestimations of the actual shooting distance under high threat. However, if this effect would be due to stronger threat-related interpretations (e.g. Nieuwenhuys et al., 2011; see also Bishop, 2007; Nieuwenhuys & Oudejans, in press), then perceptual accuracy should be maintained. Finally, with respect to the nature of the shooting response (i.e. actual *versus* verbal), we expected that being able to actually shoot the suspect would lead to more accurate perceptions of distance (e.g. Mann et al., 2010). Correspondingly, effects of threat were expected to be most pronounced in the actual response group.

METHOD

The experiment was approved by the ethics committee of the research institute. Given the involvement of firearms, it was executed under responsibility of certified police firearms instructors.

Participants

Fifty-five police officers were recruited from training classes at the local police academy and divided into two

[1] It is important to note that the current study did not investigate the effects of threat on police officers decision to shoot or not to shoot (e.g., Nieuwenhuys et al., in press) but, instead, aimed to assess whether threat-induced differences in the *timing* of police officers' shooting responses (e.g., earlier shooting) can be explained by affective influences on perception or an altered interpretation of the situation under threat. With this aim, participants always shot at the suspect.

experimental groups: an 'actual response' (AR) group and a 'verbal response' (VR) group. The AR group consisted of 34 participants (30 men, 4 women), with a mean age of 37.97 years ($SD = 9.98$) and a mean working experience of 15.21 years ($SD = 9.98$). The VR group consisted of 21 participants (16 men, 5 women), with a mean age of 37.86 years ($SD = 9.73$) and a mean working experience of 16.38 years ($SD = 9.41$). There were no significant differences between the age and working experience of both groups (ts < 1, ps > .66). All participants had a full license to carry their handgun on duty and provided written informed consent before the start of the experiment.

Design, experimental task, and conditions

Because the extent to which threatening situations elicit anxiety is known to be highly individual, we performed a within-subject manipulation of threat (see also Baumeister, 1984; Beilock & Carr, 2001; Cañal-Bruland, Pijpers, & Oudejans, 2010; Causer, Holmes, Smith, & Williams, 2011; Wilson, Vine, & Wood, 2009). As such, for both groups (AR and VR), the experiment consisted of two experimental conditions: a 'low threat' (LT) and a 'high threat' (HT) condition. Each participant performed in both conditions; the order of which was counterbalanced. In both conditions, the participants were asked to respond to a suspect who approached in a direct line and who threatened them with a knife (Figure 1). The approach speed of the suspect was constant ($M = 1.92$ m/s, $SD = 0.04$ m/s) and—as appeared from video analysis—did not differ between groups and conditions (Fs < 0.38, ps > .54). An experienced police firearms instructor acted as the suspect. Thereto, he wore a green protective overall, a face mask, and a throat protector. The participants wore their regular uniform and stood at a fixed position 10 m away from the starting point of the suspect.

As soon as the suspect started his approach, the participants were required to order him to stop and drop his knife. However, as the suspect continued to approach, they were to draw a handgun and eliminate the suspect by shooting one round at his chest. Upon being hit, the suspect would make two more steps and then fall over to the side as if he was actually shot.

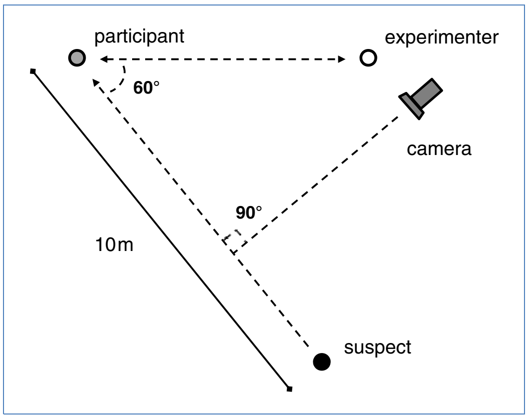

Figure 1. Overview of the experimental setup and apparatus

The participants in the AR group received a 9-mm handgun, identical to their duty weapon Walther P5 (Carl WALTHER GmbH, Ulm, Germany) but specifically prepared to fit colored-soap cartridges Simunition®, FX® marking ammunition (GD-OTS Canada Inc., Repentigny, QC, Canada). In both conditions (LT and HT), the handgun was loaded with one cartridge, which was used to actually fire at the suspect. The participants in the VR group received an imitation handgun (Bluegun® (Ring's Manufactoring, Melbourne, FL, United States), Walther P5). This handgun had no trigger and could not be used to actually fire at the suspect. Instead, the participants in the VR group acted as if they had a real handgun but indicated their shot verbally, by shortly screaming 'NOW!'.

In both conditions (LT and HT), the participants were instructed to act as if the suspect carried a real knife. In the LT condition, the knife was represented by a plastic 'dummy' knife, thereby making performance in this condition a relatively harmless experience. In the HT condition, however, the plastic knife was replaced with an electrical knife of the same size and proportions Shocknife® (Shocknife Inc., Winnipeg, MB, Canada). Being hit with the electrical knife would result in a very painful shock and, thus, was expected to create a more threatening experience for the participants. None of the participants had experience with the electrical knife. During the experiment, nobody was actually hit.

Experimental set-up and apparatus

The experiment was set up indoors, in a large 12 × 12 m dojo at the facilities of the police academy. The approach of the suspect, as well as the participants firing their handgun (either actually or verbally), were filmed from a direct angle by using a digital video camera (Creative VADO® HD (Creative Technology Ltd., Singapore) 29.97 Hz, 1200 × 780 pixels) that was placed 7 m from the suspect's approach line, in one of the corners of the room (Figure 1). For the VR group, a small size microphone, which was connected to the camera, was attached to the participants' uniform and used to identify their verbal shooting response. The images of the camera were used to calculate the distance between the suspect and the participant, at the exact moment of the participants' shot. For the AR group, this moment was identified by visual detection of gun fire (captured on a single video frame: 33.33 ms). For the VR group, this moment was identified by detecting the first video frame on which the participants started saying 'NOW!'.

Dependent variables

Manipulation check

To analyze the effect of our threat manipulation (dummy knife [LT] *versus* electrical knife [HT]), we assessed the participants' subjective ratings of anxiety on a scale of 0 to 10 by using a visual-analogue scale called the 'anxiety thermometer' (Houtman & Bakker, 1989; see also Nieuwenhuys & Oudejans, 2010, 2011; Nieuwenhuys et al., in press). Furthermore, we performed a 'beat-to-beat' analysis of the participants' heart rate by using a Polar heart rate monitor (s810; Polar Electro Oy, Kempele, Finland). With these data, maximal heart rates were calculated for each condition.

Actual shooting distance
With the images of the digital camera, we analyzed actual shooting distances by counting the number of pixels between the eyes of the participant and the eyes of the suspect at the exact moment (i.e. video frame) of the participants' shot. Pixels were then converted to centimeters by using a 'pixel-to-centimeter ratio' that was calculated on the basis of a calibration image that was made before testing. Given the current setup, the pixel-to-centimeter ratio was 0.032 cm/pixel.

Perceived shooting distance
To assess how participants perceived the distance between themselves and the suspect at the exact moment of their shot (i.e. perceived shooting distance), directly after finishing each condition (LT and HT), we asked the participants to turn 60° to the left and provide an estimate of the actual shooting distance by positioning an experimenter at the exact same distance from them (Figure 1). To achieve this, the participants ordered the experimenter to move backward and forward until the experimenter stood at the same distance from them as the suspect had stood at the exact moment of their shot (see Proffitt et al., 2003, and Witt et al., 2007, for similar measures of perceived distance). After reaching a final position, the participants were explicitly asked to confirm whether the experimenter stood at the right distance and to make adjustments when necessary.

Perceptual accuracy
Finally, to detect possible changes in perceptual accuracy, either due to threat (LT and HT) or action specificity (AR and VR), we calculated a perceptual accuracy ratio by dividing the values for 'perceived shooting distance' and 'actual shooting distance' for each participant and each condition (Clerkin et al., 2009, and Lessard, Linkenauger, & Proffitt, 2009, for a similar method to assess changes in perceptual accuracy). Doing so, a perceptual accuracy ratio below 1 indicated an underestimation of the actual shooting distance (perceiving the suspect to be closer), whereas a perceptual accuracy ratio above 1 indicated an overestimation of the actual shooting distance (perceiving the suspect to be further away).

Procedure

Each participant was measured individually during a single test session. After receiving general instructions about the task, the participants signed an informed consent, put on the heart rate equipment, and were instructed to take their position. For the participants in the VR group, the small size microphone was then attached to their uniform and the verbal response (i.e. a short and loud 'NOW!') was shortly practiced. Following this, the participants received their handgun. The suspect then came over, introduced either the plastic knife (LT) or the electrical knife (HT) and made clear that depending on the participants' response, his intention would be to try and hit the participant with that knife. After that, the opponent moved to his starting position and heart rate measurement was initiated. The trial started as soon as the suspect started his approach. Directly after finishing the trial (i.e. as soon the participants had shot at the suspect), heart rate measurement was stopped and the participants were asked to provide the perceived shooting distance (see section on Dependent Variables). Then, the participants filled in the anxiety thermometer, thereby indicating how anxious they had felt during the trial. Finally, the participants took a 1-min break before continuing with the other condition. After completing both threat conditions (LT and HT), the participants were shortly interviewed about their experiences.

Statistical analysis

To verify whether the participants were indeed more anxious in the HT than in the LT condition and to analyze the extent to which this might be different depending on response mode (AR or VR), subjective ratings of anxiety and maximal heart rates were collectively evaluated using a 2×2 (Response mode $\times$ Threat) MANOVA, with 'response mode' as a between-subjects factor and with repeated measures on 'threat' (see Nieuwenhuys & Oudejans, 2011; Nieuwenhuys et al., in press, for a similar evaluation of anxiety measures). For each of the other variables (i.e. actual shooting distance, perceived shooting distance, and perceptual accuracy), the effects of response mode (AR or VR) and threat (LT or HT) were tested using univariate 2×2 (Response mode $\times$ Threat) ANOVAs, again with 'response mode' as a between-subject factor and repeated measures on 'threat'. In all cases, significant main effects and interactions were followed-up using Bonferroni-corrected comparisons. Effect sizes were calculated using partial eta squared values (η_p^2) or Cohen's *d* where appropriate. The alpha level for significance was set at .05.

RESULTS

An overview of the results for each of the dependent variables is presented in Table 1.[2]

Manipulation check

The MANOVA for anxiety scores and maximal heart rates showed a marginally significant effect of response mode, $\lambda = .894$, $F(2, 49) = 2.90$, $p = .064$, $\eta_p^2 = .106$, a strong and significant effect of threat, $\lambda = .713$, $F(2, 49) = 9.84$, $p < .001$, $\eta_p^2 = .287$, and no significant interaction ($p = .51$).

Follow-up analyses on the marginally significant effect of response mode showed that although anxiety scores did not differ significantly between both response groups ($p = .23$), maximal heart rates were higher for the AR group than for the VR group, $F(1, 50) = 5.17$, $p = .027$, $\eta_p^2 = .094$. Follow-up analyses on the effect of threat showed that anxiety scores as well as maximal heart rates were significantly higher in the HT than

[2] To make sure that the order in which the participants performed both threat conditions (LT and HT) did not influence our findings, we performed additional analyses on each of the dependent variables, in which 'order' was included as a covariate (i.e. ANCOVA). Because the order in which the participants performed both threat conditions was counterbalanced (see section on Design, Experimental Task, and Conditions), this did not lead to notable differences with respect to the outcomes of our original analyses. As such, only the original analyses (not controlled for order) are reported in the Results section.

Table 1. Mean values (*M*) and standard deviations (*SD*) for each of the dependent variables for the actual response and verbal response group, in the low threat (LT) and high threat (HT) condition

Variable		Condition LT *M* (*SD*)	Condition HT *M* (*SD*)
Anxiety score (0–10)			
	Actual response	4.38 (2.01)	5.07 (2.11)
	Verbal response	3.87 (1.94)	4.22 (1.26)
Maximal heart rate (beats/min)			
	Actual response	131.72 (18.75)	137.75 (20.86)
	Verbal response	119.65 (19.91)	125.35 (18.73)
Actual shooting distance (cm)			
	Actual response	289.14 (96.00)	328.44 (121.82)*
	Verbal response	353.04 (109.71)	335.97 (126.95)
Perceived shooting distance (cm)			
	Actual response	239.29 (94.82)	282.53 (120.33)**
	Verbal response	251.19 (93.91)	238.33 (98.18)
Perceptual accuracy			
	Actual response	0.82 (0.18)	0.86 (0.22)
	Verbal response	0.70 (0.12)	0.72 (0.18)

'Perceptual accuracy' was calculated by dividing the variables 'Perceived shooting distance' and 'Actual shooting distance'.
*$p < .05$,
**$p < .01$

in the LT condition, $F(1, 50) = 12.79$, $p = .001$, $\eta_p^2 = .204$ and $F(1, 50) = 14.260$, $p < .001$, $\eta_p^2 = .222$ (Table 1).

Taken together, these results confirm that although actually shooting the suspect was more arousing than providing a verbal response, the participants generally experienced more anxiety in the HT condition than the LT condition. This indicates that our manipulation of threat was successful.

Actual shooting distance

The ANOVA for shooting distance showed a significant interaction between response mode and threat, $F(1, 53) = 4.17$, $p = .046$, $\eta_p^2 = .073$, and no significant main effects (*p*s > .21). Follow-up analyses on the interaction effect showed that shooting distance of the AR group was significantly larger in the HT than in the LT condition ($p = .026$, $d = .48$), whereas this was not the case for the VR group ($p = .430$). In addition, the VR group shot the suspect earlier (i.e. at a greater distance) than the AR group in the LT condition ($p = .027$, $d = .62$) but not in the HT condition ($p = .829$; Table 1).[3]

Perceived shooting distance

The ANOVA for perceived shooting distance also only showed a significant interaction between response mode and threat, $F(1, 53) = 7.74$, $p = .007$, $\eta_p^2 = .127$, and no significant main effects (*p*s > .21). Similar to actual shooting distance, follow-up analyses showed that perceived shooting distance for the AR group was significantly larger in the HT than in the LT condition ($p = .001$, $d = .65$), whereas this was not the case for the VR group ($p = .421$; Table 1).

Perceptual accuracy

The ANOVA for perceptual accuracy showed a significant main effect of response mode, $F(1, 53) = 7.58$, $p = .008$, $\eta_p^2 = .125$, no effect of threat ($p = .25$), and no interaction ($p = .71$). As appeared from the main effect of response mode, the perceptual accuracy ratio of the AR group was significantly higher than that of the VR group (Table 1). This result indicates that distance perception was more accurate when participants were allowed to actually shoot the suspect. To make sure that this difference was really due to an effect of response mode, and not to any between-group differences regarding the experience of threat, we executed bivariate correlations between perceived and actual shooting distances. These correlations showed that, in all cases, perceived and actual shooting distances were strongly related, with $r = .85$, $p < .001$ (LT) and $r = .81$, $p < .001$ (HT) for the AR group and $r = .88$, $p < .001$ (LT) and $r = .84$, $p < .001$ (HT) for the VR group. In Figure 2, we plotted the accompanying regression lines. As can be seen in the figure, regression lines indicate no effect of threat but confirm that perceptual accuracy was better for the AR group than for the VR group (Figure 2).

DISCUSSION

In the current study, we investigated the effects of threat and response mode on the perceptual judgments and shooting behavior of police officers. Officers were confronted with a suspect that approached with a knife and shot at the suspect when he came too close. Afterwards, they were asked to provide perceptual estimates of the distance at which they had

[3] Research on stimulus–response compatibility shows that in response to visual stimuli, latencies for verbal responses may be slightly longer than for manual responses (e.g. Eimer & Schlaghecken, 2001; Wang & Proctor, 1996). We did not assess response latencies in our experiment. However, with these findings, one could speculate that shooting distance of the verbal response group might—if at all—show a minimal increase, thereby further increasing the already observed difference in shooting distance between both response groups.

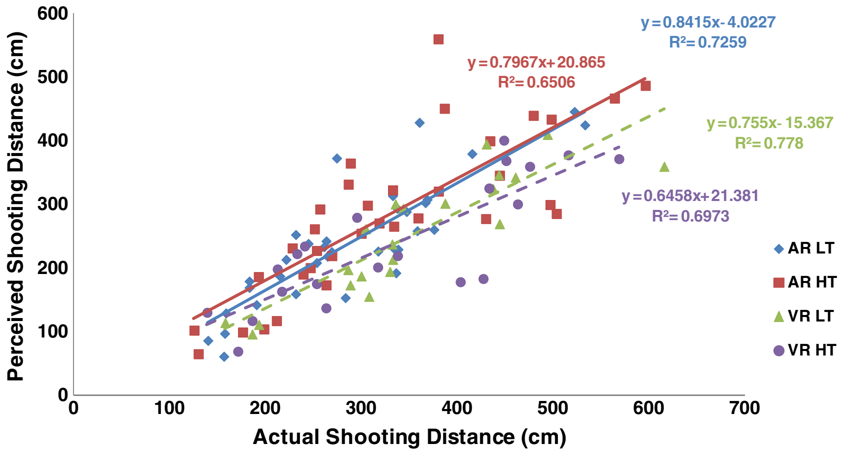

Figure 2. Regression lines for perceived and actual shooting distances in the low threat (LT) and high threat (HT) conditions and for the actual response (AR; solid lines) and verbal response (VR; dashed lines) groups

shot at the suspect. To manipulate threat, the suspect used either a plastic dummy knife (LT) or an electrical knife (HT). To manipulate response mode, one group of participants shot the suspect by using a real handgun loaded with colored-soap cartridges (AR group) while another group used an imitation handgun and indicated their shot by screaming ‘NOW!’ (VR group).

On the basis of previous work, we predicted that our manipulation of threat would lead to an increase in state anxiety in the HT condition, thereby causing participants to shoot earlier (i.e. at a greater distance; e.g. Corell et al., 2002; Nieuwenhuys & Oudejans, 2010, 2011; Nieuwenhuys et al., in press; Payne, 2001). Underlying this effect, we aimed to test whether increases in shooting distance (earlier shooting) would be due to the following: (i) affective influences on perception, which would cause participants to perceive the suspect as being closer (e.g. Clerkin et al., 2009; Stefanucci & Proffitt, 2009; Teachman et al., 2008), or (ii) increased threat-related interpretations, which would leave distance perception unaltered but would cause participants to be quicker in interpreting the situation as ‘worthy of shooting’ (e.g. Nieuwenhuys et al., in press). In case of the first, increases in actual shooting distance under HT should be accompanied by decreases in perceptual accuracy (i.e. underestimation). In case of the latter, increases in actual shooting distance under HT should not be accompanied by decreases in perceptual accuracy (i.e. perceptual accuracy should be maintained). Finally, we predicted that distance perception would be most accurate when participants were allowed to actually shoot at the suspect (e.g. Mann et al., 2010).

First of all, our analysis of subjectively reported anxiety and maximal heart rates confirmed that participants experienced more anxiety in the HT than in the LT condition. Although on average the observed differences were not large (i.e. 0.52 points with respect to anxiety score and 5.9 beats/min with respect to maximal heart rate; Table 1) the observed effects were consistent, comparable with earlier studies (e.g. Oudejans, 2008) and, hence, likely to have affected participants’ shooting responses.

Indeed, the participants in the AR group shot the suspect at a larger distance when they were more anxious (i.e. in the HT condition). That is, the distance at which participants shot the suspect increased by 13.6%, from 289 cm in the LT condition to 328 cm in the HT condition (Table 1). This result is comparable with earlier studies of police officers’ shooting behavior and confirms that when officers are anxious (e.g. afraid to get shot) their shooting response becomes significantly faster (e.g. Nieuwenhuys & Oudejans, 2010, 2011; Nieuwenhuys et al., in press).

Interestingly, the observed increase in *actual* shooting distance, from the LT to the HT condition, was matched by a similar increase in *perceived* shooting distance (Table 1). This was also reflected in our measure of perceptual accuracy, which remained constant throughout the experiment, and showed no additional effect of threat on the degree to which participants underestimated the distance to the suspect. Finally, in support of these findings, perceived and actual shooting distances consistently showed strong positive correlations, again indicating no effect of threat (see also Figure 2). Given our relatively small sample size, one should be cautious in interpreting null findings. With all caution, however, these results seem to indicate that, for the AR group, actual shooting distances did not increase under HT because increased anxiety caused participants to perceive the suspect as being closer (e.g. Clerkin et al., 2009; Stefanucci & Proffitt, 2009; Teachman et al., 2008).

If it is true that threat-induced increases in anxiety did not affect distance perception, an alternative explanation for the effect on shooting distance may be that when participants were more anxious, they might have interpreted the suspect as being more dangerous. As such, rather than affecting basic perceptual processes (i.e. distance perception), anxiety may have promoted a threat-related interpretation of the situation (e.g. Bishop, 2007; Nieuwenhuys & Oudejans, in press), thereby causing participants to shoot earlier (Nieuwenhuys et al., in press; see also Correll et al., 2002; Payne, 2001). Although more research is needed to substantiate this argument, this result is in line with the findings of Woods, Philbeck and Danoff (2009), observed that effort-related effects on distance judgements are more likely to reflect changes in response calibration than altered perceptions of distance.

Despite the fact that our measure of perceived shooting distance appeared sensitive enough to detect differences as a result of threat (Table 1), we were unable to find evidence of affective influences on perception (Proffitt, 2006a, 2006b). With respect to the nature of responses that participants provided, this may signal the importance of action. That is, whereas previous studies investigated perceptual judgments in relation to implicitly (or explicitly) *intended* actions (see also Witt & Proffitt, 2008), our study examined perceptual judgments in relation to *actually executed* actions (i.e. in this case to shoot the suspect). Future work should further investigate this matter and explore the extent to which affective influences on perception may be restricted to those situations that do not explicitly involve the execution of action.

Regarding the difference between actually shooting the suspect and verbally indicating a shot (i.e. AR group *versus* VR group), it appeared that threat-induced increases in anxiety only caused earlier shooting when participants were allowed to actually shoot at the suspect. The same effect was found for *perceived* shooting distance. With respect to perceptual accuracy, it appeared that participants in the AR group were significantly more accurate than participants in the VR group (Table 1). In general, participants underestimated the distance to the suspect. However, whereas the AR group showed underestimations of less than 20% (comparable with earlier studies of Proffitt et al., 2003 and Witt et al., 2007), the VR group showed underestimations of almost 30% (Figure 2). These findings confirm earlier observations of Mann et al. (2010; see also Króliczak et al., 2006, 2007) and seem to support the idea that perceptual accuracy is reduced when the nature of responses is less action specific (Milner & Goodale, 1995; Van der Kamp et al., 2008).

It is likely that the lack of perceptual accuracy that characterized participants in the VR group also caused them to generally shoot the suspect at greater distances (i.e. retain a larger safety margin) and be less sensitive to threat. With respect to police training and education, this indicates that training procedures should be sufficiently action specific to allow for realistic (shooting) responses (e.g. Nieuwenhuys & Oudejans, 2011; Oudejans, 2008). Furthermore, because in the current setting distance related to time, the fact that participants in the AR group were quicker to shoot the suspect in the HT condition suggests that increased anxiety may decrease the time during which officers allow a suspect to respond to their orders (e.g. to drop their weapon), thereby strongly influencing the outcome of a developing incident. It should be noted, however, that in the current setup, the suspect always continued to approach and threaten the officers and that officers always shot at the suspect. This is different from real-life situations, in which there are more behavioral options for both the officer and the suspect. For example, an officer can choose to shoot or not to shoot (e.g. Nieuwenhuys et al., in press) and a suspect may or may not drop his or her knife. With these differences, future work is needed to explore whether the current findings hold under more realistic circumstances. Finally, our observation that officers may underestimate shooting distances with almost 20% (actual shooting responses) has considerable consequences for the reconstruction of incidents during legal investigation. These reconstructions are often based on the retrospective reports of officers that are involved in such incidents and, hence, should take this perceptual inaccuracy into account.

In conclusion, the current study investigated the effects of threat and response mode on the perceptual judgments and shooting behavior of police officers. Regarding the effects of threat, it appeared that, in the online control of action, threat-induced increases in anxiety may cause police officers to be quicker in shooting at an approaching suspect. Regarding the effects of response mode, it appeared that perceptual accuracy (i.e. judging the distance to the suspect at the exact moment of shooting) was better for actual than verbal shooting responses. Although threat-induced increases in anxiety did affect shooting behavior, perceptual accuracy was maintained and participants consistently underestimated the distance to the suspect. With these findings, it is suggested that rather than affecting basic perceptual processes (i.e. distance perception), anxiety may alter the functional relationship between distance and perceived threat, thereby causing officers to shoot the approaching suspect at an earlier stage.

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